Arsenic Species in Frozen Human Urine

The Centers for Disease Control and Prevention (CDC) has established a network of laboratories to monitor arsenic exposure throughout the U.S. by measuring arsenic species in urine. To ensure accuracy of these measurements, CDC is collaborating with NIST to develop a new frozen urine Standard Reference Material (SRM) to be certified for arsenic species. Human exposure to arsenic comes primary from two sources -- drinking water and food. Depending on the source, arsenic may be present in several chemical forms that differ greatly in toxicity.

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Work is progressing on a three-year project in which NIST and CDC are collaborating to produce SRM 2669 Arsenic Species in Frozen Human Urine, which is the first frozen urine SRM and the first SRM to be certified for multiple arsenic species. Each unit of the SRM will consist of two different urine samples containing arsenic species that appear in human urine following ingestion of foods with naturally occurring arsenic compounds and of arsenic-containing drinking water. The two urine pools were formulated by mixing analyzed sub-lots of urine to produce mixtures with the desired species and levels. The candidate SRM has been bottled and frozen and certification measurements are presently underway. In response to earlier studies that indicated that the presence of dissolved oxygen could adversely affect the stability of some arsenic species, the urine mixtures were sparged with nitrogen to remove oxygen, and the SRMs were bottled in nitrogen-containing glove boxes. The candidate SRM units are packaged in sealed gas-impermeable Mylar bags that contain an oxygen absorber.

Concentrations of seven arsenic species (arsonite, arsonate, monomethyl-arsonate, dimethylarsinate, trimethylarsine oxide, arsenobetaine, and arsenocholine) and total arsenic will be certified in the urine. Each analyte will be present at a normal level and an elevated level near the 95 percentile as determined by CDC population studies. The elevated levels are not all contained in the same sample. Certified values for the arsenic species will be based on measurements performed at NIST (both in Gaithersburg and at NIST's facility at the Hollings Marine Laboratory in Charleston) and measurements performed by expert laboratories including the CDC, the Armed Forces Institute of Pathology, Rutgers University, and Brock University (Canada). The chromatogram shown in the figure was obtained using a method that was developed for this project; species are separated using ion chromatography with element-specific detection of arsenic by inductively coupled plasma mass spectrometry (ICP-MS). The figure shows that each of the seven arsenic species is detected with baseline separation in the Level II urine.

SRM 2669 will be the first frozen urine reference material with values assigned for all important arsenic species. An earlier Certified Reference Material produced by the National Institute for Environmental Studies in Japan is based on freeze-dried urine and is not certified for the As^{+3} and As^{+5} species, which are the most toxic arsenic species and, therefore, critical for detection of arsenic poisoning. The frozen urine matrix of SRM 2669 is better suited for the intended purpose to validate the methods and measurements for urine analysis. Release of the new SRM is planned for early 2008.

SRM 2669 Arsenic Species in Frozen Human Urine will provide the accuracy base for biomonitoring of arsenic exposure. Concentrations of seven arsenic species indicative of different sources of arsenic exposure will be certified.